

44th CGSIC Meeting - Timing Session
Tuesday, 20 September 2004, 13:30

Chair: *Włodzimierz Lewandowski, BIPM*

Co-Chair: *Victor Zhang, NIST*

13:30	Introduction	<i>W. Lewandowski, BIPM</i>
13:45	Report from NIST	<i>V. Zhang, NIST</i>
14:00	USNO Report	<i>D. Matsakis, USNO</i>
14:15	An Architecture for Galileo Time	<i>J. Hahn, ESA (invited)</i>
15:00	NRL Precise Time Activities	<i>R. Beard, NRL</i>
15:15	Time transfer Research at USNO	<i>D. Matsakis, Ed Powers</i> <i>F. Vannicola, USNO</i>
15:30	Report from APL	<i>M. Miranian, APL</i>
15:45	Finding Time and Place: Previewing a Proposed Smithsonian Exhibition	<i>C. E. Stephens, National Museum of American History</i>
16:00	Extending the GPS Paradigm to Space Exploration	<i>R. A. Nelson, Satellite Engineering Research Corporation, Bethesda, MD</i>
16:15	Discussion	
16:30	Session End	

AREAS BEING SERVED

- **International Atomic Time (TAI) and UTC**
- **International Timing Centers**
- **Primary Frequency Standards**
- **Telecommunications Industries**
- **NASA/JPL Deep Space Network**
- **NIST Global Time Service**
- **Power Grids and other Industries**
- **As Research and Comparison Tool**
- **Other**

MEETING ANNOUNCEMENT

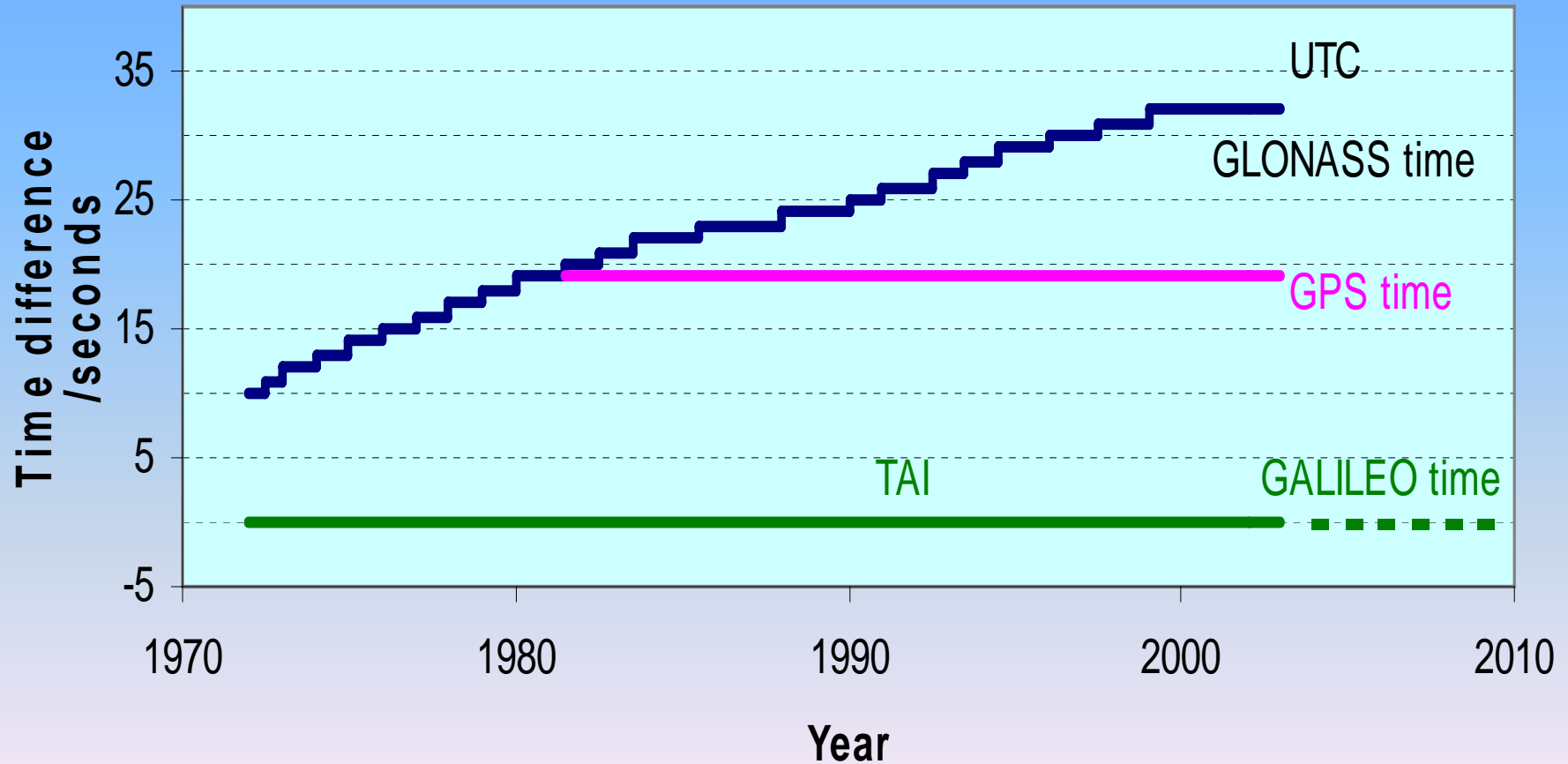
- **International Workshop on Galileo Time**
2004 September 27-28, Turin, Italy
- **CCTF WG on TWSTFT**
2004 October 14-15, NICT, Tokyo, Japan
- **36th Annual PTTI**
2004 December 6-9, Washington DC, USA
Hyatt Regency on Capitol Hill
- **EFTF**
2005 March 21-24, Besançon, France

Unification of time

- 1884 - Adoption of a prime meridian Greenwich and of an associated time
- 1948 - *International Astronomical Union* recommends the use of Universal Time (UT)
- 1971 - *International Astronomical Union, International Telecommunications Union, Conférence Générale des Poids et Mesures* recommend the use of Coordinated Universal Time (UTC). Introduction of leap seconds.
- 2003 - Use of leap seconds under revision



$[TAI - \text{Time scale}(i)]$



Suggested transition to a uniform time scale

1. Any change should slowly evolve from the current UTC by transition to a uniform time scale.
2. The final time scale should have a new name to distinguish it from Universal Time, since Universal Time is generally understood to be linked to Solar Time, and the earth rotation. A new name suggested was International Time, *Temps International* (TI).
3. A suggested date inaugurating any change would be 2022, the 50th anniversary of the UTC time scale. The date suggested was influenced by the beyond the lifetime of currently existing systems that would expensive to change.

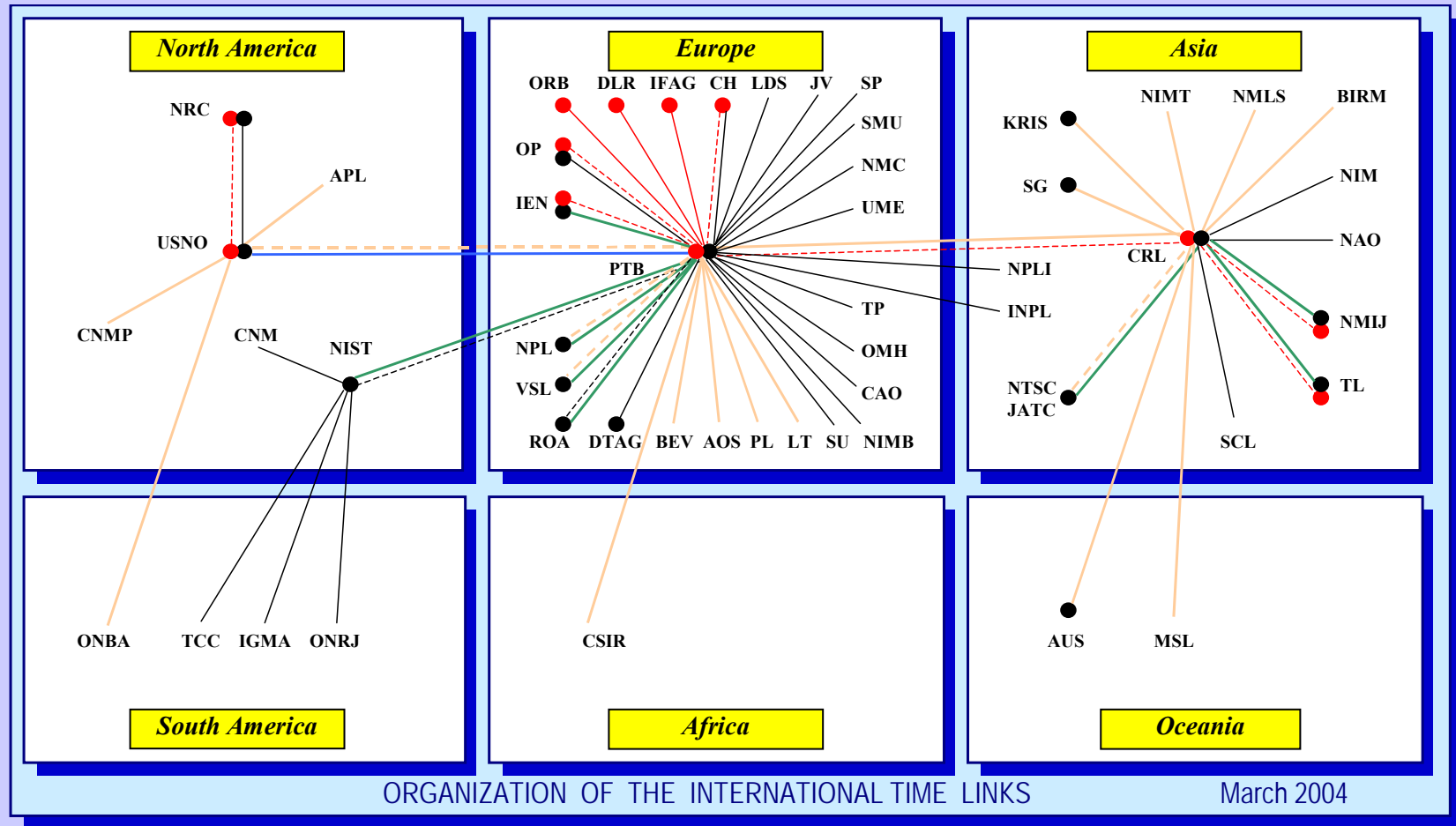


Suggested transition to a uniform time scale (cont.)

4. **TI should be a continuous atomic time scale without Leap Seconds that is synchronized with UTC at the time of transition.**
5. **UT1 information would continue to be made available under the sole responsibility of the IERS.**



International time links



BIPM differential calibrations of GPS time equipment

Uncertainty 3 ns (1 σ)

- In 2002/2004 nine campaigns were carried out involving: AOS, APL, CH, IEN, KRIS, IEN, NICT, NIST, NMIJ, NML, NPL, OCA, OP, NPL, NTSC, PTB, ROA, TL, USNO, VSL
- *Ongoing:* OP, NTSC, HKO, SCL, TL, SG, NML, KRISS, NMIJ, NICT
- *Ongoing:* OP, TCC, ONBA, IGMA, ONRJ, CNMP, CNM, NIST, USNO, NRC

In total 30 laboratories out of the 56 that participate in TAI have been calibrated.



Some past GPS calibrations between NIST and OP

d is the differential time correction to be added to $[UTC(NIST) - UTC(OP)]$, and $u(d)$ is the estimated uncertainty for the period of comparison

Date	d/ns	$u(d)/\text{ns}$
July 1983	0	2
Sept 1986	1	2
Octo 1986	-1	2
Jan 1988	-4	3
Apr 1988	1	3
Mar 1995	-4	1
May 1996	-1	2
May 2002	-5	3
July 2003	-6	2
Dec 2003	-5	3

Differential calibrations of TWSTFT equipment

Uncertainty $< 1 \text{ ns}$ (1σ)

- In 2001/2004 several calibrations were conducted by USNO and TUG
- March 2001: USNO, NPL
- June 2002: USNO, PTB
- June 2003: IEN, PTB
- July 2004: PTB, OP, VSL, NPL
- Several occasions: USNO/AMC
- Repeated calibrations show consistency better than 1 ns
- BIPM will be involved in some of these campaigns

Comparison of GPS CV and TWSTFT Calibration of the IEN/PTB Time Link

In June 2003, a simultaneous calibration of the IEN/PTB time link by GPS CV and TWSTFT portable equipment was conducted by the Technical University of Graz (TUG) for TWSTFT, and by the BIPM for GPS CV. Below is provided comparison of two calibrations.

Differential time correction d to be added to $[UTC(IEN) - UTC(PTB)]$, and its estimated uncertainty $u(d)$ for the period of comparison (1σ).

Method	d/ns	$u(d)/\text{ns}$
TWSTFT	-1.0	1.0
GPS CV	3.2	3.0

**Differences between TWSTFT and GPS CV
before and after applying calibration corrections
for IEN/PTB for the period 4 June – 29 July 2004**

<i>UTC(IEN) – UTC(PTB)</i>	(TWSTFT – GPS) /ns	
	Mean	rms
Before calibration corrections	5.0	1.7
After calibration corrections	0.8	1.7

Some time links used for the computation of TAI and their uncertainties

Link Lab1/Lab2	Type Lab1/Lab2	uA/ns	uB/ns	Calibration Type Lab1/Lab2	Calibration Dates Lab1/Lab2
AOS/NPL	GPS MC	1.5	5.0	GPS EC/GPS EC	2003 Sep/2003 Aug
BIRM/CRL	GPS MC	4.0	20.0	NA /GPS EC	NA /2003 Nov
CNM /NIST	GPS SC	5.0	20.0	NA /GPS EC	NA /2003 Jul
CSIR/PTB	GPS MC	3.0	20.0	NA /GPS EC	NA /2003 Dec
IEN /PTB	TWSTFT	1.0	1.0	LC (TWSTFT)	2003 Jun
IFAG/PTB	GPS P3	0.7	5.0	GPS EC/GPS EC	2003 Jun/2003 Aug
NIST/PTB	TWSTFT	0.5	5.0	LC(GPS SC)	2003 Sep
NPL /PTB	TWSTFT	0.5	5.0	LC(GPS SC)	1999 Nov
OP /PTB	GPS SC	2.5	5.0	GPS EC/GPS EC	2004 Jan/2004 July
ORB /PTB	GPS P3	0.7	5.0	GPS EC/GPS EC	2003 Jul/2003 Aug
USNO/PTB	TWSTFT	0.5	3.0	BC(GPS P3)	2003 Sep



44th CGSIC - Timing subcommittee



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